WHAT IS CLAIMED IS:

1. A self-supported III-V nitride semiconductor substrate having a substantially uniform carrier concentration distribution at least on its outermost surface.

2. A self-supported III-V nitride semiconductor substrate having a substantially uniform carrier concentration distribution in a surface layer existing from the top surface to a depth of at least 10 μm.

3. A self-supported III-V nitride semiconductor substrate comprising a first layer having a plurality of regions different in a carrier concentration from their surroundings in a direction substantially perpendicular to a substrate surface, and a second layer existing from the top surface to a depth of at least 10 μm, said second layer being substantially free from said regions with different carrier concentrations, thereby having a substantially uniform carrier concentration distribution

4. A self-supported III-V nitride semiconductor substrate, wherein there are not high-brightness regions and low-brightness regions with clear boundaries in a fluorescence photomicrograph of its surface layer existing from the top surface to a depth of at least 10 μm.

5. A self-supported III-V nitride semiconductor substrate comprising a first layer having high-brightness regions and low-brightness regions with clear boundaries and a second layer composed of a high-brightness region from the top surface to a depth of at least 10 μm in a fluorescence photomicrograph in its arbitrary cross section, said low-brightness regions and said high-brightness regions being different in a carrier concentration.

6. A self-supported III-V nitride semiconductor substrate comprising substantially no regions different in a carrier concentration from their surroundings in a surface layer existing from the top surface to a depth of at least 10 μm.

7. The III-V nitride semiconductor substrate according to any one of claims 1, wherein said substrate has a carrier concentration of 1×10^{17} cm^{-3} or more, and wherein variations in the carrier concentration are within ± 25% in said outermost surface.

8. The III-V nitride semiconductor substrate according to any one of claims 2 or 4 or 6, wherein said substrate has a carrier concentration of 1×10^{17} cm^{-3} or more, and wherein variations in the carrier concentration are within ± 25% in said surface layer.

9. The III-V nitride semiconductor substrate according to any one of claims 3 or 5, wherein said substrate has a carrier concentration of 1×10^{17} cm^{-3} or more, and wherein variations in the carrier concentration are within ± 25% in said second layer.

10. The III-V nitride semiconductor substrate according to any one of claims 1, wherein said substrate has a carrier concentration of less than 1×10^{17} cm^{-3}, and wherein variations in the carrier concentration are within ± 100% in said outermost surface.

11. The III-V nitride semiconductor substrate according to any one of claims 2 or 4 or 6, wherein said substrate has a carrier concentration of less than 1×10^{17} cm^{-3}, and wherein variations in the carrier concentration are within ± 100% in said surface layer.

12. The III-V nitride semiconductor substrate according to any one of claims 3 or 5, wherein said substrate has a carrier concentration of less than 1×10^{17} cm^{-3}, and wherein variations in the carrier concentration are within ± 100% in said second layer.

13. The III-V nitride semiconductor substrate according to any one of claims 1 to 6, wherein variations in the carrier concentration are not larger on its top surface than on its bottom surface.

14. The III-V nitride semiconductor substrate according to claim 3 or 5,

wherein said regions with different carrier concentrations are in a planar shape with a wedge-like cross section.

15. The III-V nitride semiconductor substrate according to claim 3 or 5, wherein said regions with different carrier concentrations are substantially in a shape of a cone, a hexagonal pyramid or a dodecahedral pyramid.

16. The III-V nitride semiconductor substrate according to claim 14, wherein said regions with different carrier concentrations have the maximum width of 1 mm or less.

17. The III-V nitride semiconductor substrate according to any one of claims 1 to 6, wherein its top surface is polished.

18. The III-V nitride semiconductor substrate according to any one of claims 1 to 6, wherein its bottom surface is polished.

19. The III-V nitride semiconductor substrate according to any one of claims 1 to 6, wherein it has a thickness of 200 μm to 1 mm.

20. The III-V nitride semiconductor substrate according to any one of claims 1 to 6, wherein the top surface of said substrate is a (0001) group-III surface.

21. The III-V nitride semiconductor substrate according to any one of claims 1 to 6, wherein it has a dislocation density lower on a top surface than on a bottom surface.

22. The III-V nitride semiconductor substrate according to any one of claims 1 to 6, wherein it comprises a layer of GaN or AlGaN.

23. The III-V nitride semiconductor substrate according to any one of claims 1 to 6, wherein said III-V nitride semiconductor crystal is doped with an impurity.

24. The III-V nitride semiconductor substrate according to any one of claims 1 to 6, wherein at least part of said III-V nitride semiconductor crystal is grown by an HVPE method.

25. A method for producing a III-V nitride semiconductor substrate comprising growing a III-V nitride semiconductor crystal while forming a plurality of projections on a crystal growth interface at the initial or intermediate stage of crystal growth; conducting said crystal growth until recesses between said projections are buried, so that said crystal growth interface becomes flat; and continuing said crystal growth to a thickness of 10 μm or more while keeping said crystal growth interface flat.

26. A method for producing a III-V nitride semiconductor substrate comprising (a) forming a first layer having a nonuniform carrier concentration distribution, by growing a III-V nitride semiconductor crystal while forming a plurality of projections on a crystal growth interface at the initial or intermediate stage of crystal growth, and by further conducting said crystal growth until recesses between said projections are buried, so that said crystal growth interface becomes flat; and (b) forming a second layer having a substantially uniform carrier concentration distribution to a thickness of 10 μm or more by continuing said crystal growth while keeping said crystal growth interface flat.

27. A method for producing a III-V nitride semiconductor substrate comprising (a) forming a first layer having a nonuniform carrier concentration distribution, by growing a III-V nitride semiconductor crystal while forming a plurality of projections on a crystal growth interface at the initial or intermediate stage of crystal growth, and by further conducting said crystal growth until recesses between said projections are buried, so that said crystal growth interface becomes flat; (b) forming a second layer having a substantially uniform carrier concentration distribution by continuing said crystal growth while keeping said crystal growth interface flat; and (c) polishing a top surface of said substrate after the completion of said crystal growth, such that a remaining second layer has a thickness of

10 μm or more.

28. A method for producing a III-V nitride semiconductor substrate comprising the steps of forming a III-V nitride semiconductor layer on a top surface of a different substrate by epitaxial growth, and then separating said III-V nitride semiconductor layer from said different substrate, wherein crystal growth is conducted while forming a plurality of projections on a crystal growth interface at the initial or intermediate stage of growing said III-V nitride semiconductor layer; wherein crystal growth is then conducted until recesses between said projections are buried, so that said crystal growth interface becomes flat; and wherein crystal growth is further continued to a thickness of 10 μm or more while keeping said crystal growth interface flat.

29. A method for producing a III-V nitride semiconductor substrate comprising the steps of forming a III-V nitride semiconductor layer on a top surface of a different substrate by epitaxial growth, and separating said III-V nitride semiconductor layer from said different substrate, (a) wherein a first layer having a nonuniform carrier concentration distribution is formed by conducting crystal growth while forming a plurality of projections on a crystal growth interface at the initial or intermediate stage of growing said III-V nitride semiconductor layer, and by further conducting crystal growth until recesses between said projections are buried, so that said crystal growth interface becomes flat; and (b) wherein a second layer having a substantially uniform carrier concentration distribution is formed to a thickness of 10 μm or more by continuing said crystal growth while keeping said crystal growth interface flat.

30. A method for producing a III-V nitride semiconductor substrate comprising the steps of forming a III-V nitride semiconductor layer on a top surface of a different substrate by epitaxial growth, and then separating

said III-V nitride semiconductor layer from said different substrate, (a) wherein a first layer having a nonuniform carrier concentration distribution is formed, by conducting crystal growth while forming a plurality of projections on a crystal growth interface at the initial or intermediate stage of growing said III-V nitride semiconductor layer, and by further conducting said crystal growth until recesses between said projections are buried, so that said crystal growth interface becomes flat; (b) wherein a second layer having a substantially uniform carrier concentration distribution is formed by continuing said crystal growth while keeping said crystal growth interface flat; and (c) wherein a top surface of said substrate is polished after the completion of said crystal growth, such that a remaining second layer has a thickness of 10 μm or more.

31. A method for producing a III-V nitride semiconductor substrate comprising (a) forming a first layer having a nonuniform carrier concentration distribution, by growing a III-V nitride semiconductor crystal while forming a plurality of projections on a crystal growth interface at the initial or intermediate stage of crystal growth, and by further growing said crystal until recesses between said projections are buried, so that said crystal growth interface becomes flat; (b) forming a second layer having a substantially uniform carrier concentration distribution by continuing said crystal growth while keeping said crystal growth interface flat; and (c) removing at least part of said first layer grown while forming a plurality of projections on a crystal growth interface, after the completion of said crystal growth.

32. A method for producing a III-V nitride semiconductor substrate comprising the steps of forming a III-V nitride semiconductor layer on a top surface of a different substrate by epitaxial growth, and then separating said III-V nitride semiconductor layer from said different substrate, (a)

wherein a first layer having a nonuniform carrier concentration distribution is formed, by growing said III-V nitride semiconductor crystal layer while forming a plurality of projections on a crystal growth interface at the initial or intermediate stage of crystal growth, and by further conducting said crystal growth until recesses between said projections are buried, so that said crystal growth interface becomes flat; (b) wherein a second layer having a substantially uniform carrier concentration distribution is formed by continuing said crystal growth while keeping said crystal growth interface flat; and (c) wherein at least part of said first layer, which is grown while forming a plurality of projections on a crystal growth interface, is removed after the completion of said crystal growth.

33. The method for producing a III-V nitride semiconductor substrate according to claim 31, wherein at least part of said first layer, which is grown while forming a plurality of projections on a crystal growth interface, is removed by polishing the bottom surface of said substrate, so that the thickness of said substrate does not become less than 200 μm.

34. The method for producing a III-V nitride semiconductor substrate according to claim 32, wherein at least part of said first layer, which is grown while forming a plurality of projections on a crystal growth interface, is removed by polishing the bottom surface of said substrate, so that the thickness of said substrate does not become less than 200 μm.

35. A method for producing a III-V nitride semiconductor substrate comprising (a) forming a first layer having a nonuniform carrier concentration distribution, by growing a III-V nitride semiconductor crystal while forming a plurality of projections on a crystal growth interface at the initial or intermediate stage of crystal growth, and by further conducting said crystal growth until recesses between said projections are buried, so that said crystal growth interface becomes flat; (b) forming a second layer

having a substantially uniform carrier concentration distribution by continuing said crystal growth while keeping said crystal growth interface flat; and (c) cutting said second layer in a direction perpendicular to said crystal growth after the completion of said crystal growth, thereby obtaining a crystal substrate.

36. A method for producing a III-V nitride semiconductor substrate comprising the steps of forming a III-V nitride semiconductor layer on a top surface of a different substrate by epitaxial growth, and then separating said III-V nitride semiconductor layer from said different substrate, (a) wherein a first layer having a nonuniform carrier concentration distribution is formed, by growing said III-V nitride semiconductor layer while forming a plurality of projections on a crystal growth interface at the initial or intermediate stage of crystal growth, and by further conducting crystal growth until recesses between said projections are buried, so that said crystal growth interface becomes flat; (b) wherein a second layer having a substantially uniform carrier concentration distribution is formed by continuing said crystal growth while keeping said crystal growth interface flat; and (c) wherein said second layer is cut in a direction perpendicular to said crystal growth after the completion of said crystal growth, thereby obtaining a crystal substrate.

37. The method for producing a III-V nitride semiconductor substrate according to any one of claims 31 to 36, wherein the top surface of said substrate is mirror-polished so that the thickness of said substrate does not become less than 200 μm.

38. The method for producing a III-V nitride semiconductor substrate according to any one of claims 31 to 36, wherein all of said first layer is removed.

39. The method for producing a III-V nitride semiconductor substrate

according to any one of claims 25 to 36, wherein recesses in the roughness formed on said crystal growth interface at the initial or intermediate stage of said crystal growth are in a V-shaped or inversed-trapezoidal shape in a cross section in parallel to said crystal growth direction, which is surrounded by facet planes.

40. The method for producing a III-V nitride semiconductor substrate according to any one of claims 25 to 36, wherein recesses between projections formed in said crystal growth interface at the initial or intermediate stage of said crystal growth are in a conical shape surrounded by facet planes.

41. The method for producing a III-V nitride semiconductor substrate according to any one of claims 25 to 36, wherein at least part of said crystal growth is carried out by an HVPE method.

42. The method for producing a III-V nitride semiconductor substrate according to any one of claims 25 to 36, wherein a hydrogen concentration in a growth atmosphere gas is made higher than in the previous steps to bury the roughness of said crystal growth interface during said crystal growth.

43. The method for producing a III-V nitride semiconductor substrate according to any one of claims 25 to 36, wherein the partial pressure of a group-III source is made higher than in the previous steps to bury the roughness of said crystal growth interface during said crystal growth.

44. The method for producing a III-V nitride semiconductor substrate according to claim 35 or 36, wherein both top and bottom surfaces of a cutout substrate are polished.

45. A lot composed of a plurality of III-V nitride semiconductor substrates, wherein all of said substrates are the III-V nitride semiconductor substrates recited in any one of claims 1 to 6.